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Prevalence of Malaria and Helminth Infections and Their Link to Knowledge on Preventive Strategies among Asymptomatic Pupils in Rural-urban Cameroon

Jean Thierry Ebogo-Belobo [a,b], Rodrigue Roman Dongang-Nana [a], Lucie Josiane Ojong [a], Edward Ndzi [a], Nathalie Amvongo-Adjia [a,b], Lesley Ngum Ngum [a], Ginette Irma Kame-Ngasse [a], Ngwene Hycentha Diengou [a,c], Efietngab Atembeh-Noura [a], Ousmanou Djabidatou [a], Salioh Mbuh [a] and Valérie Makoge [a*]

[a] Institute of Medical Research and Medicinal Plants Studies, Yaoundé, P.O. BOX 13033, Cameroon.
[b] University of Yaoundé 1, Cameroon.
[c] University of Nsukka, Nigeria.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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**Corresponding author: Email: valmakoge@yahoo.co.uk;*

ABSTRACT

Aim: The aim of our study was to investigate the prevalence of malaria and helminth infection among asymptomatic primary school children in rural and urban Yaoundé-Cameroon, to assess pupils' knowledge about malaria and STH infection, and to evaluate the association between this knowledge and actual disease prevalence.
Study Design: This study was a cross-sectional and was carried out between October 2019 and December 2019 in six primary schools in the Centre region of Cameroon.
Methodology:Pupils in classes 3 to six were recruited for the study. Blood and stool samples were collected and analysed to determine pupils' disease prevalence. Questionnaires following the KAP and health belief model frameworks were administered to evaluate pupils' health literacy in malaria and helminths.
Results: 457 pupils from rural and urban zones participated in this study. 245 (53.6 %) were female and 212 (46.4 %) were male. The prevalence of anaemia was higher in urban than rural zones. Total malaria prevalence was 17.7%. Malaria parasitaemia prevalence classified according to settings revealed rural zones at 28.6% and urban zones at 13.9%. STH infection showed a total prevalence of 4.8% and 7.9% and 3.7% in rural and urban zones respectively. The prevalence of co-infection was 1.2%. Health-literacy gaps in malaria and helminths were identified. Schooling in rural settings and being older were predictors for having a good knowledge of the diseases. However, having good knowledge was not significantly associated to actual malaria parasitaemia or STH prevalence.
Conclusion: Insights from this study are essential for the implementation of successful, sustainable and targeted health-promotion strategies to improve the health and well-being of pupils.

Keywords: Malaria; helminths; KAP; Cameroon; anaemia; primary school children.

1. INTRODUCTION

The design and effective implementation of school health programmes requires information on major health burdens of pupils that affect their learning outcomes [1]. In sub-Saharan Africa, malaria which remains one of these burdens and has been indexed as a major cause of morbidity and mortality in the region. The World Health Organization (WHO) in its 2020 report [2], estimated that there were 241 million new malaria cases in the world and 627000 malaria-related deaths in about 5 countries. Of these, more than a quarter of the deaths were registered in Sub Saharan Africa [2]. Malaria morbidity has been shown to be a main reason for many absences observed in schools in this region.

In Cameroon as well, malaria remains a major cause of morbidity and mortality especially in children [3]. Six million malaria cases are registered every year in health facilities [4]. However, not all malaria cases end up in the hospital. Many people visit the health facilities only when the infection is severe [4]. The WHO reports 11000 malaria-related deaths in the country [5]. In addition, the National Malaria Control Programme in Cameroon reports malaria as a reason for 29.9% of Heath facility consultations, 64% of hospitalisations and 14.3% deaths at these facilities [3].

Another parasitic infection known as helminthiasis (soil transmitted helminths - parasitic worm- infections) has been known to be endemic in places where malaria is endemic. The World Health Organization (WHO) reports that up to 1.5 billion people worldwide are infected with soil-transmitted helminths (STH) i.e. 24% of the world's population [6]. The transmission route of these parasites is through their eggs which are present in the faeces of human carriers and which contaminate the soil in poor hygiene areas. A heavy burden of these parasites impairs physical and mental growth in children and stunts their educational progress. These STH are highly prevalent in environments of poverty, deprivation, poor sanitation and lack of clean and potable water [7]. In Cameroon, despite Mass Drug Administration (MDA) with single dose anti-helminthic medication in primary schools as a parasite control mechanism, STH infections still persists as a public health concern [8].

Given their similar habitat, it is possible to find people infected with both parasites at the same time; A phenomenon known as co-infection. Worldwide, a third of the population is reportedly

infected with intestinal helminths or Plasmodium parasites [8]. Both malaria and helminthiasis even though preventable and curable, are endemic in both urban and rural areas in sub-Saharan Africa [9]. Furthermore, a synergistic or antagonistic interaction between the two parasites has been reported. A study in Nigeria reported a protective effect of helminth infection against malaria in children below 10 years of age. This protective effect is thought to be lost as the children grow older [10]. It is therefore important that measures be taken to prevent these infections in school-aged children especially as both infections are important contributors to anaemia often seen in this group of people [9, 11, 12]. Childhood anaemia, is considered to be a serious public health problem since it has consequences on the cognitive development and growth of children [4]. One of the effects MDA is to reduce the prevalence of anaemia by targeting worms which contribute to it [13]. The trio of malaria, STH and anaemia remains a pressing public health concern to be addressed [5]. To this end, some countries have put in place strategies geared towards eliminating these parasites and condition respectively [3]. That notwithstanding, the hurdle of asymptomatic carriers which make up a great proportion of the population makes this an uphill task [5]. In fact, asymptomatic carriers tend to be disease reservoirs and contribute to the maintenance and continuous spread of parasites within the population [14]. Also, peoples lack of agency due to individual perceptions or lack of knowledge, can contribute to this spread and maintenance. Identifying therefore asymptomatic pool of carriers stands as a step towards effective control and elimination of the disease [14]. In addition, identifying individual perceptions, and disease-related knowledge, could improve the likelihood of success. Unfortunately, few studies have combined the aspects of disease-prevention knowledge to actual burden/prevalence of disease and even fewer have focused on primary school children (pupils) in such investigations. Actually, working with pupils can give an indication of what is happening or give of the picture of disease incidence in the communities [6]. With emphasis being placed on elimination in many countries, the role of individuals and communities cannot be ignored.

The aim of our study therefore, was to determine the prevalence of malaria and helminth infection among asymptomatic primary school children in rural and urban Yaoundé, Cameroon, to assess pupils' knowledge about malaria and STH infection, and to evaluate the association between this knowledge and actual disease prevalence.

2. MATERIALS AND METHODS

2.1 Study Design and Setting

This study was cross-sectional in nature and was carried out between October 2019 and December 2019. The Centre region was selected for this study because it has the highest incidence of malaria in the country [3]. Six primary schools in the Centre region of Cameroon were enrolled. These were *Ecole Publique (EP) d'Odza 1A, Ecole Publique d'Odza 2* (found in Minkan Yaoundé) and *Ecole Publique d'Ekounou 1A, Ecole Publique d'Ekounou 3A*, Government Primary School (GPS) Ekounou group 1 and Government Primary School Ekounou Group 2 (found in Ekounou, Yaoundé)**.** The schools in Minkan (3.7643° N, 11.5254° E) are found in the rural zones of Yaoundé while the schools in Ekounou (3.8438° N, 11.5348° E) are found in the urban zones of Yaoundé. In this study, the term 'rural' refers to an area with sparse population in the outskirts of Yaoundé while the term 'urban' refers to a densely populated area found in the city of Yaoundé, Cameroon. The EPs Odza 1A and Odza 2 primary schools shared the same school premises. Likewise EPs Ekounou 1A and Ekounou 3A and GPS Ekounou group 1 and Ekounou Group 2. Some schools used the premises in the morning while others used in the afternoons. This followed a rotatory pattern (or shift system due to a shortage of school buildings). Ekounou group 1 and Ekounou group 2 were the only primary schools included in the study which followed the English sub-system of Education.

2.2 Approach Used to Include Study Participants

In this study, we used the whole population approach instead of the sample calculation approach. With this approach, we included all pupils from class 3 to class 6 (in the Anglophone primary schools and its equivalent classes in the francophone primary schools (cours éléméntaire 1 to cours moyens 2) who parents signed the informed consent form allowing their children to participate. Findings from pupils at this level of education can stand as a proxy for disease burden and knowledge about disease and

prevention strategies in their communities. The reason for including these classes in the study was because at this level, pupils can read and understand questions. That notwithstanding, the researchers and class teachers were present to assist the pupils.

2.3 Theoretical Framework and Survey Instrument

A questionnaire was designed following the Knowledge Attitude and Practices (KAP) and Health Belief Model (HBM) frameworks [15]. Elements of interest from KAP included, knowledge and attitudes about disease prevention strategies against malaria and STHs as well as hygiene practices. The second framework: HBM stipulates that the health-related action of people is formed from their perceptions. Elements from the HBM on which focus was made in this study include: Perceived severity of disease and perceived vulnerability towards the disease. According to HBM, pupils would be more likely to take action if they perceived malaria and STH infections as severe and if they perceived they were at risk of becoming infected. Furthermore, it stipulates that pupils would engage in a specific protective/preventive action if they perceived those actions to be beneficial [15].

The study questionnaire was administered by the research team with the help of teachers from each primary school. A slightly different version of the questionnaire was administered to the parents of pupils. The parents were requested to fill the questionnaires at home and return it through their children alongside informed consent forms permitting their children to be part of the study. The results of the study involving the parents is reported elsewhere. The study questionnaire consisted of 40 closed ended questions that aimed to collect the following information from children: 10 items on demographics (such as age, gender, school, class, residence), 11 items on malaria Knowledge (regarding malaria definition and clinical presentations, malaria transmission route, malaria prevention et control), 5 items on malaria attitude (regarding malaria prevention practice and use of the mosquito net) and 14 items on helminth knowledge (regarding helminth definition, helminth transmission route, helminth prevention and control). Questions were answered on a Yes/No basis with an additional “I don’t know” option. Examples of questions asked the children were: What is malaria? How can malaria be prevented? What will make you NOT to sleep using a mosquito net? Can diseases be transmitted through faeces? What are worm infections?

2.4 Scoring of Responses Obtained from Questionnaire

Each correct answer for knowledge and attitude questions was scored: 1 point and each wrong answer, or an ‘I don’t know’ answer was scored: 0 point. The total knowledge score for malaria, ranged from 0 to 11 points (Low 0-3; Medium 4-7 and High 8-11). The total knowledge score on helminths ranged from 1 to 14 points. Children’s attitudes towards the diseases, was also investigated. ‘Attitudes towards malaria’ score ranged from 0 to 5 points (Poor 0-1; Average 2-3 and Good 4-5). A higher score was an indication of more knowledge or a good attitude with respect to the disease. Overall scores were used to calculate mean scores for knowledge and attitudes aspects.

2.5 Data and Sample Collection

Anthropometric data (height and weight) for each participant was collected. The height of participants was measured using a seca 225 statometer. The weight was obtained using a weighing scale. In addition, a medical doctor who was part of the team examined the children for skin, teeth, and nail infections and general appearance (i.e. conditions of the school uniforms and shoes. The temperature of each pupil was taken to check for the presence or absence of fever.

With regards to biological samples, blood and stool samples were collected from each pupil. Blood samples were collected using the finger prick method. From the prick, two drops of blood were deposited on a slide for thin and thick blood film examination. Another drop of blood was put into the well of strips of URIT-12 haemoglobinometer for quantitative measurement of total haemoglobin in fresh whole blood. Pupils with results indicating haemoglobin values less than 11g/dl were considered to be anaemic [16].

Pupils were given plastic stool sample bottles (with scoop incorporated) and asked to put a scoopful (about 3g) of faecal matter into the containers and return to the researchers. About 3mg/g of faecal matter of sodium azide was added into each container and was stirred. This was to prevent the decomposition of parasite

eggs. The stool samples were then transported to the laboratory in an ice packed flask for analysis.

2.6 Laboratory Analyses

2.6.1 Parasitology

The number of asexual parasites per 200 leucocytes was counted from Giemsa stained thick blood films using light microscopy. A slide was considered negative only after scanning 100 high power fields. All slides were read independently twice by experienced medical laboratory technicians and a third reading was done by an expert where discrepancy arose.

The Kato-Katz technique was used for the identification (based on their morphology) and quantification of the parasite eggs [17]. The 41.7 mm plastic template was used for measuring stool before smearing. Stool samples on slides were covered with cellophane that had been previously soaked in glycerol and pressed to ease observation under the microscope [17].

2.7 Data Analysis

Analysis: Descriptive statistics for knowledge of- and attitudes towards- malaria and STH in the study population were calculated. Independent samples t-tests and Pearson's Chi-square test were used where necessary to compare the difference of means or proportions between groups. For the purposes of binary logistic regression analysis, all those with a high score were coded as 'yes', and those with low and medium score were coded as 'no'. Odds ratios and respective 95% confidence intervals (CI) were used to quantify the associations between variables and knowledge and attitudes. A p-value of less than 0.05, was considered significant in all tests. Statistical analyses were conducted using IBM SPSS for Windows, v. 25.0 (IBM Corp., Armonk, USA).

2.8 Ethical Statement

This study received ethical and administrative clearances from the Institute of Medical Research and Medicinal Plants Studies (IMPM) institutional review board (N/Ref.: 087/82-62/MINRESI/M000) and the Inspectorate of Basic Education of the Yaoundé 4 district, Centre region of Cameroon respectively. In addition, an information sheet and informed consent form was sent to parents of the pupils in selected classes of targeted schools one week before the study. A written consent was obtained from every parent who desired that their child(ren) participate in the study. Only children whose parents signed and returned the informed consent form and who assented were enrolled in the study.

3. RESULTS

3.1 Socio-Demographic Characteristics

A total of 457 primary school children participated in this study. Of these, 245 (53.6 %) were female and 212 (46.4 %) were male. The average age of the participants was about 10 years old. Participants in this study were enrolled from classes 3 to classes 6. Amongst the participants, 253 (55.4%) perceived their quality of life status to be average, 83 (18.2 %) perceived themselves to be rich, while 121 (26.5 %) perceived themselves to be poor. The physical appearance of the pupils showed dirty nails, skin infections like scabies, ringworm, rashes etc. Some pupils had torn uniforms and shoes in need of repairs. Even though this phenomenon was more common in the rural schools, it was also seen in the urban primary schools.

Study participants were enrolled from two distinct settings. The urban setting (Ekounou) with 294 pupils (64.3%) and the rural setting (Minkan) with 163 pupils (35.7 %). Table 1 indicates the socio-demographic characteristics of the pupils and in terms of urban or rural settings.

There was no significant difference in basic socio-demographic characteristics amongst the participants from the rural and urban environments and this permitted combination of the whole study population in certain analysis. The household capacity of the pupils was reported on average as 5-7 people per household. However, 32% of the participants, reported living in households having more than 7 people.

3.2 Facilities/ Amenities at Home

Regarding facilities/ amenities in the pupils' households, 375 (80%) respondents reported having mosquito nets in their homes. The main reason, given, for not using mosquito nets was the discomfort due to heat perceived during use. 275 (62.4%) used traditional toilets (pit latrine), 233 (51%) did not have running water at home, 77% used public taps, 14.7% used rivers and 8.3% used wells as sources of drinking water.

Table 1. Socio-demographic characteristics of the pupils according to settings

		Schools		
	Overall	**Ekounou (%)**	**Minkan (%)**	***P***
Age (means±SD) ; min-max	9.8±1.7	9.8±1.6	9.7±1.7	.70
Age group (years)				0.17
• 5-7	36 (7.9)	19 (6.5)	17 (10.4)	
• 8-10	280 (61.3)	188 (63.9)	92 (56.4)	
• >11	141 (30.9)	87 (29.6)	54 (33.1)	
Sex				.75
• Female	245 (53.6)	156 (53.1)	89 (54.6)	
• Male	212 (46.4)	138 (46.9)	74 (45.4)	
Class				<.001
• Class 3 (CE1)	89 (19.5)	33 (11.2)	56 (34.4)	
• Class 4 (CE2)	125 (27.4)	89 (30.3)	36 (22.1)	
• Class 5 (CM 1)	41 (30.9)	94 (32.0)	47 (28.8)	
• Class 6 (CM2)	102 (22.3)	78 (26.5)	24 (14.7)	
Perceived quality of life				.04
• Poor	121 (26.5)	69 (23.5)	52 (31.9)	
• Average	253 (55.4)	163 (55.4)	90 (55.2)	
• Rich	83 (18.2)	62 (21.1)	21 (12.9)	
Number of people in the home				.02
• 2-4	80 (17.5)	61 (20.7)	19 (11.7)	
• 5-7	230 (50.3)	148 (50.3)	82 (50.3)	
• More than 7	147 (32.2)	85 (28.9)	62 (38.0)	
Presence of mosquito net at home				.75
• No	82 (17.9)	54 (18.4)	28 (17.2)	
• Yes	375 (82.1)	240 (81.6)	135 (82.8)	
Type of toilets in the home				.12
• Water closet	168 (36.8)	98 (33.3)	70 (42.9)	
• Pit toilet	285 (62.4)	193 (65.6)	92 (56.4)	
• None	4 (0.9)	3 (1.0)	1 (0.60)	
Tap water at home				.45
• No	233 (51.0)	146 (49.7)	87 (53.4)	
• yes	224 (49.0)	148 (50.3)	76 (46.6)	
Drinking water sources				.28
• Wells	38 (8.3)	27 (9.2)	11 (6.7)	
• Public tap	352 (77.0)	229 (77.9)	123 (75.5)	
• Stream/ river	67 (14.7)	38 (12.9)	29 (17.8)	

3.3 Facilities/Amenities Offered by the Schools

Our study showed that toilet facilities in the different schools were of very poor hygiene conditions (dirty, floor spluttered with faeces, walls dirty and humid etc.). Only pit toilets were present for use in all schools. All the different urban primary schools used the same toilet facility. That was the same case in the rural setting. There were no taps with running water, no water basins for hand-washing, no soap bars observed in the different schools. Water was carried from small streams found around the school premises. Children also played in this water. Water from the streams was used for cleaning classrooms and throwing on toilet floors to push faeces into the pit since pupils sometimes defecate on the toilet floor instead of the pit. There were no employed toilet cleaners. The toilets in the urban primary schools did not have doors. There were neither health dispensaries nor sick bays were present in any of the schools.

3.4 Malaria, Helminth and Anaemia Prevalence amongst Pupils

Table 2, shows the prevalence of malaria and STH infection amongst asymptomatic children in

primary schools in urban and rural Yaoundé. Malaria prevalence in general was 17.7% (80/420). When categorised according to settings, it was seen that malaria prevalence was higher in the schools in the rural zones of Yaoundé (28.6%) than in the urban part of Yaoundé (13.9%). With regards to STH infection, the total infection prevalence was 4.8% (22/424). Specifically, helminth prevalence was higher in Minkan (rural zone) schools (7.9%) than in Ekounou (urban) schools (3.7%). There were significant differences in both malaria and STH prevalence within the settings. *Ascaris lumbricoides* was the most prevalent helminth infection seen in both settings. Other parasites seen were Trichocephalus and Schistosoma spp. Bloody urine (an indication of schistosomiasis) was observed in a pupil in the rural settings. Also, worms in the adult forms were seen in stool samples of some pupils in urban settings.

Co-infection of malaria and STH which implies multi-parasitic infestation was found in 1.2 % of pupils.

In this study, the overall mean haemoglobin level was 12.1±2.1 g/L and this level was significantly higher in Ekounou pupils compared to Minkan pupils (*P*=.003). The prevalence of anaemia in general was 18.8% i.e. anaemia was detected in 86 pupils who participated in this study. However, when categorised according to the different settings, it was observed that, unlike what was seen with disease prevalence, which was higher in the rural zones than the urban zones, anaemia was more pronounced in the urban setting than the rural setting. Specifically, in Ekounou pupils, the prevalence of anaemia was 25.6% while in Minkan, the prevalence was 14.2%. This difference was significant (*P*=.007).

3.5 Knowledge and Perception about Malaria among Primary School Children

More than half of all pupils (53%) reported that they received information on malaria from their parents. Only 36% said they got information from their schools. The majority knew that malaria was transmitted by a mosquito bite (66%). However, there were some pupils (10 %) who said it was transmitted through drinking from the same glass. Additionally, 28% perceived malaria to be the same as fever, 14% considered malaria to be stomach ache while 18 % did not know what malaria was. Table 3, presents the knowledge of the pupils in relation to malaria. Being Older, and in Class 6, or CM2, were the only socio-demographic factors significantly related to having a high knowledge score on malaria questions. In general, children had good knowledge about different aspects of malaria (overall low score < 10%). Females had higher knowledge than their male counterparts. Participants who considered themselves to be of average quality of life, had higher knowledge about malaria than those who considered themselves to be poor or rich. However, children over the age of 11, those in the class 6 level and those in Minkan Schools (rural settings) had the best knowledge of malaria. Logistic regression analysis revealed that being a pupil in Minkan, (OR=2.02; 95% IC=1.29-3.15; *P*=.002) and being in class 6 level, were factors associated to high knowledge scores on malaria (Table 3). With regards to attitude, only age was linked to having a good attitude towards malaria in our study.

With regards to protective behaviours, our study showed that 64 % of pupils reportedly carried out some action to prevent malaria. In fact, 66% of pupils reportedly slept under the mosquito net the night before the study. We also investigated pupils' perceptions about malaria, and our findings showed that 38% of respondent's perceived malaria to be severe, i.e. a deadly disease, With regards to perceived vulnerability of the pupils, 66% did not consider themselves to be vulnerable to a malaria infection.

3.6 Knowledge and Perceptions about Helminths

Table 4, describes the relationship between socio-demographic characteristics of participants and knowledge about preventing helminth infection. Factors, which significantly related to high knowledge were once again age, and class. There was no difference in knowledge level between rural and urban schools. Only 5.3% females were highly knowledgeable about helminths. No male scored high in the knowledge about helminths aspect. In general, pupils were not highly knowledgeable about helminth infections, with most having an average score (overall low score around 20%). When the perceived severity of worm infections by respondents was investigated, findings showed that 56% of the pupils, perceived worm infections to be dangerous, 28%, did not perceive worm infections to be dangerous while about 15% reported not to know whether worm infections were dangerous or not. Results showed that, being older, being female, and being in class 6

were linked to having a high knowledge on helminths (*P*<.05). In addition, logistic regression analysis, revealed that attending school in Minkan, (OR=3.22 95% IC=1.73-6.01; *P*<.001) was a predictor of high knowledge on STHs (Table 4).

Table 2. Prevalence of malaria and geo-helminth infection amongst asymptomatic children in primary schools in urban and rural Yaoundé

		Schools		
	Overall	**Ekounou (%)**	**Minkan (%)**	***P***
Haemoglobin (means±SD) g/L	12.1±2.1	11.9±2.2	12.6±1.8	.003
Anaemia				
• No	316 (69.1)	189 (74.4)	127 (85.8)	.007
• Yes	86 (18.8)	65 (25.6)	21 (14.2)	
Malaria (n=420)				<.001
• Negative	339 (74.2)	235 (86.1)	105 (71.4)	
• Positive	80 (17.7)	38 (13.9)	42 (28.6)	
STH (n=424)				.06
• Negative	402 (88.0)	262 (96.3)	140 (92.1)	
• Positive	22 (4.8)	10 (3.7)	12 (7.9)	
Type of STH seen (n=424)				
• Ascaris	14 (3.3)	8 (2.9)	6 (3.9)	.58
• Trichocephalus	6 (1.4)	1 (0.4)	5 (3.3)	.02
• Schistosoma	5 (1.2)	2 (0.7)	3 (2.0)	.35

Table 3. Knowledge of participants in relation to malaria infection and prevention

		Knowledge about malaria			***P***
	Mean±SD	**Low (n=27)**	**Medium (n=219)**	**High (n=211)**	
Age group (years)					.001
• 5-7	6.2±1.9	4 (11.1)	22 (61.1)	10 (27.8)	
• 8-10	6.8±2.1	22 (7.9)	138 (49.3)	120 (42.9)	
• ≥13	7.6±1.9	1 (0.7)	59 (41.8)	81 (57.4)	
Sex					.82
• Female	7.0±2.0	13 (5.3)	117 (47.8)	115 (46.9)	
• Male	6.9±2.1	14 (6.6)	102 (48.1)	96 (45.3)	
School					.20
• Ekounou	6.9±2.0	16 (5.4)	150 (51.0)	128 (43.5)	
• Minkan	7.3±2.3	11 (6.6)	69 (42.3)	83 (50.9)	
Class					<.001
• Class 3 (CE1)	5.9±2.1	13 (14.6)	54 (60.7)	22 (24.7)	
• Class 4 (CE2)	6.8±1.9	8 (6.4)	62 (49.6)	55 (44.0)	
• Class 5 (CM 1)	7.2±2.2	6 (4.3)	69 (48.9)	66 (46.8)	
• Class 6 (CM2)	7.9±1.6	0 (0.0)	34 (33.3)	68 (66.7)	
Perceived quality of life					.17
• Poor	6.5±2.2	11 (9.1)	62 (51.2)	48 (39.7)	
• Average	7.2±2.1	13 (5.1)	113 (44.7)	127 (50.2)	
• Rich	7.0±1.9	3 (3.6)	44 (53.0)	36 (43.4)	
Number of people in the home					.74
• 2-4	7.1±1.9	6 (7.5)	38 (47.5)	36 (45.0)	
• 5-7	6.9±2.1	13 (5.7)	116 (50.4)	101 (43.9)	
• > 7	7.1±2.2	8 (5.4)	65 (44.2)	74 (50.3)	

Table 4. Relation between socio-demographic characteristics of pupils and helminth infection and prevention knowledge

		Knowledge about helminth			*P*
	Mean±SD	**Low (n=82)**	**Medium (n=362)**	**High (n=13)**	
Age group (years)					.04
• 5-7	5.7±2.1	4 (11.1)	31 (86.1)	1 (2.8)	
• 8-10	5.6±1.9	61 (21.8)	214 (76.4)	5 (1.8)	
• ≥13	6.2±1.9	17 (12.1)	117 (83.0)	7 (5.0)	
Sex					.002
• Female	6.0±2.0	39 (15.9)	193 (78.8)	13 (5.3)	
• Male	5.6±1.8	43 (20.3)	169 (79.7)	0 (0.0)	
School					.002
• Ekounou	5.5±1.8	63 (21.4)	227 (77.2)	4 (1.4)	
• Odza	6.3±2.0	19 (11.7)	135 (82.8)	9 (5.5)	
Class					.001
• Class (CE1)	5.7±2.1	19 (21.3)	67 (75.3)	3 (3.4)	
• Class (CE2)	5.3±1.9	31 (24.8)	93 (74.4)	1 (0.8)	
• Class (CM 1)	5.9±1.7	22 (15.6)	118 (83.7)	1 (0.7)	
• Class (CM2)	6.4±1.9	0 (0.0)	84 (82.4)	8 (7.8)	
Perceived quality of Life					.60
• Poor	5.6±2.0	26 (21.5)	92 (76.0)	3 (2.5)	
• Average	6.0±2.0	41 (16.2)	203 (80.2)	9 (3.6)	
• Rich	5.5±1.7	15 (18.1)	67 (80.7)	1 (1.2)	
Number of people in the home					.99
• 2-4	5.8±2.0	14 (17.5)	63 (78.8)	3 (3.8)	
• 5-7	5.7±2.0	42 (18.3)	182 (79.1)	6 (2.6)	
• More than 7	5.9±1.8	26 (17.7)	117 (79.6)	4 (2.7)	

3.7 Knowledge about Hygiene Practices as a Methods of Disease Prevention among the Children

Given that the infectious diseases: malaria and STH are transmitted favourably in areas of poor hygiene practices, we sought to evaluate basic knowledge about using hygiene practices to counteract disease from the respondents. Our study showed that majority of respondents irrespective of whether they were in the urban or rural zones knew that drinking-water containers had to be cleaned and covered and that boiling water could kill germs. However, only 10% reported that the water they drank the day before the study was boiled. 34.4% of children reportedly washed their hands more than three times a day when water was available. In addition, 75% of the pupils said they bathed twice a day and a similar percentage reported they brushed twice a day using toothpaste and a tooth brush. Furthermore, 80% of the children, reported that they used toilet paper after a toilet visit.

3.8 Association between Malaria and Helminth Related Knowledge and Disease Prevalence

Attending school in the rural setting (Minkan) and being older were predictors for having a good knowledge on malaria and helminth infections. Our results showed that having good knowledge about malaria and STH was not significantly associated with actual malaria or helminth prevalence. This is presented Table 5.

4. DISCUSSION

In this study, we determined the prevalence of malaria and helminth infection among asymptomatic primary school children in rural and urban zones of Yaoundé, Cameroon, assessed pupils' knowledge about malaria and

Table 5. Association between knowledge about malaria and helminths and infectious disease prevalence

	Malaria		
	Positive	**Negative**	***P***
Knowledge about malaria			
• Low	5 (6.3)	19 (5.6)	
• Medium	47 (58.8)	154 (45.3)	.07
• High	28 (35.0)	167 (49.1)	

	Helminths		
	Positive	Negative	*P*
Knowledge about helminth			
• Low	4 (5.5)	69 (94.5)	
• Medium	18 (5.3)	321 (94.7)	.71
• High	50 (0)	12 (100)	

STH infection, and evaluated the association between this knowledge and actual disease burden/prevalence. The endemic nature of the diseases and the negative impact they have on learning outcomes of pupils were the main reasons for our interest [4]. The socio-demographic characteristics of our respondents showed that most were living in conditions lacking basic necessities such as tap water and water closet toilets predisposing them to unhygienic conditions and increased risk of disease. The epidemiological insights revealed, are necessary for improving interventions to promote health.

4.1 Disease Burden/ Parasite Infection

Our results showed that the prevalence of both malaria and helminth infections, were higher in the rural zones than the urban zones. This is similar to reports of other studies in Osun Nigeria, in Rwanda [18, 19] as well as in Cameroon [20]. This finding, also falls in line with reports from the Ministry of Health in Cameroon [3]. It is however different from a study on school children carried out in the Southwest region, Cameroon. In said study, the prevalence of malaria was higher in the urban zones due to favourable climatic conditions [4]. Moreover, the prevalence of helminth infections in rural areas, have been attributed to poor hygiene conditions, common in these areas. Our study revealed an overall prevalence of STH as 4%. This is lower than prevalence reported in India (more than 50%) [21], as well as a 14.7 % prevalence reported in a recent study in the West region of Cameroon [22]. Even though our reported prevalence is low, it is higher than what has been reported from other primary school studies in the country. In Buea for example, a lower prevalence's of STH of 2.5% [23], or even 1% [24] have been reported. Free administration of anthelminthic drugs in schools could explain this low prevalence. As in other studies, *Ascaris lumbricoides* was the most prevalent STH observed. However, hookworm infections, which are usually seen as prevalent in other studies was not highly prevalent in our study. This could be because of the rapid clearance of hookworm eggs with delays in transportation. Whipworm, was the second most common intestinal parasite seen. This was followed by Schistosoma parasites. The presence of infected water bodies and constant contact of pupils with said water for swimming, classroom and toilet cleaning may explain the presence of Schistosoma parasite infections in the pupils.

Our results showed a malaria parasitaemia prevalence of 17.7%. This is higher than what was reported in school children in the South-Tongu district of Ghana, and lower than what was reported in Yaoundé [20] and Buea [25]. In the latter study, which was also carried out on pupils, the difference in parasitaemia could be attributed to improved measures over the years to combat malaria in the country. The level of parasitaemia observed in this study can be considered as moderate and may be linked to preventive actions, such as sleeping using mosquito nets by participants living in this endemic zone. The prevalence of urban anaemia in this study was 25%. That means one out of every four pupils in the urban zone was anaemic. This is higher than what was reported in primary school children in Ethiopia [25] or previously in

Ghana [26]. It is also higher than reports from two studies in Cameroon on asymptomatic primary school children [4, 8]. Furthermore, it was interesting to see that unlike malaria and STH prevalence, anaemia prevalence was higher in the urban setting than the rural setting. This is especially so because these diseases which are known to be contributors to anaemia were relatively lower in this setting. In fact, studies have shown that the combined effects of malaria and helminthiasis exacerbates anaemia in children [4]. Our results therefore may indicate that additional factors are contributing to this high prevalence of anaemia in the urban setting. Further research can probe in to nutrition-related causes in this setting.

4.2 Knowledge and Perceptions about Diseases

Having a good knowledge about disease and prevention strategies is essential for protecting oneself and others from disease.

4.2.1 Malaria

Our study revealed that more than half of the pupils had a good knowledge and attitude about malaria. This percentage, is higher than what was found in Zimbabwean primary school children, [27]. That notwithstanding, it was also revealed in our study that 18% of the pupils did not know what malaria was and 14% considered malaria to be stomach ache. This level of ignorance or incorrect knowledge is not negligible, and indicates a need for targeted malaria-education programs/topics to be included in school curricula. Our respondents mentioned practicing some protective measures to prevent malaria. Sleeping using a mosquito net the night before the study was used as a proxy for preventive measures undertaken by participants. 66% of participants reportedly slept using mosquito nets the night before the study. This percentage can be increased, with a higher awareness of the benefits and this can be included in health-education talks. The effectiveness of such messages, can be increased, when people's perceptions are taken in to consideration in the design. Approaches such as the HBM that enable the assessment of perceptions about malaria (in this case) in order to determine the probability of a health-related action are timely. The HBM stipulates that health-related action of people is formed from their perceptions. In other words, it is only when people (in this case pupils) perceive a risk, weigh to see that benefits outweigh hindrances, that they would likely perform a health-related behaviour (such as sleeping under a mosquito net). Our study showed that most pupils (66%) did not consider themselves to be susceptible to malaria attack. This could mean a lesser seriousness amongst these pupils regarding taking preventive measures, and an increased risk of becoming infected. That notwithstanding, it should be noted that in malaria-endemic countries, this is a common phenomenon. Since malaria is very common, most people perceive it as something they can handle. A previous study, reported that people working in plantations and living in camps in Cameroon, considered malaria to be part of their daily lives [28]. This had an implication on how they responded to the disease when they fell sick.

4.2.2 Helminths (STH)

Our study findings suggest that, our call for special health education programs on tropical diseases in school curricular should emphasize topics on STH. This follows from our results, which revealed that, pupils in general were much less knowledgeable about STH than malaria. In fact, few studies have investigated primary school children's knowledge on STH. This target group is important because they fall among the high risk groups for STH infection given that, they are more likely to engage in risky behaviours which increase their chances of becoming infected or propagating the disease in their communities [27]. Other studies have reported a relatively low knowledge about STHs [29]. Our findings showed that, pupils in the class 6 level generally had more knowledge than those in lower classes. This can be attributed to relatively more years spent in school or with parents by the older pupils that may have given them more opportunities to learn about these diseases than those in the junior and mid-primary. It was interesting to see that, even with the mediocre knowledge on helminths, the infection burden was relatively low. Reported protective attitudes such as regular handwashing could be the reason for this low prevalence. In addition, mass drug administration, usually done just before the pupils go for long holidays, could also be a contributing factor to this low prevalence. This is mostly done in the rural areas and so it was surprising to see that the STH prevalence was still higher among rural pupils. This could be linked to the significant role poorer hygiene conditions play in maintaining and spreading diseases in rural settings. With regards to

disease perception, unlike in the perceived severity of malaria which was 38%, 56% of the pupils perceived STH as severe. This findings go in line with preventive actions reported and could indicate more caution taken in preventing STH infection than malaria and may further explain the low prevalence seen.

4.3 Association between Knowledge and Disease Prevalence

Our study did not see a significant association between good knowledge scores and malaria or helminth prevalence. This unexpected trend mimics reported findings whereby swimming in dams in schistosomiasis-endemic regions was not associated to the disease and failure to own and use a mosquito net was not associated to malaria prevalence [12]. It is important to note here that our respondents were asymptomatic pupils and our study cross-sectional. Further research can follow a longitudinal design or investigate this finding with people having clinical malaria.

5. CONCLUSION

Our study, on one hand revealed anaemia, malaria parasitaemia and STH prevalence among asymptomatic pupils. The presence of parasites in apparently healthy children indicates that the continuous presence of reservoirs for disease transmissions. The low prevalence of STH in the settings could be an indication that the mass drug administration of anthelminthics is an effective strategy reducing STH burden. On the other hand, our results showed that children's awareness on malaria and helminths increases with their level of education. This information can be used jointly by the Ministry of Public Health and the Ministry of Basic Education to develop tools to raise children's awareness (in children of lower classes especially), such as the MOSKI KIT® tool developed by SANOFI in 2013, which is already being used in other African countries.

6. STUDY LIMITATIONS

Firstly, the prevalence of Hookworm infections was very low in this study. Using Sodium azide to preserve the eggs could have resulted in the clearance of some of the parasite eggs. Further studies in the centre region of Cameroon are needed to confirm our findings. Secondly, our study was cross-sectional in design. While this is a valid research approach, a longitudinal design following up the pupils for a certain period would have enable us to track who eventually feel sick of malaria or STH and link those findings to knowledge scores. This is an avenue further research can follow.

CONSENT

An information sheet including study objectives as well as the procedure to be followed and informed consent forms were sent to pupils parents/caregivers one week before the study. Only children whose parents/caregivers signed the informed consent form as proof of written consent, participated in the study. Assent was received from the children. Participation was strictly voluntary, and parents or caregivers were free at any point in time to stop the participation of the child/children in the study.

ETHICAL APPROVAL

This study received ethical and administrative clearances from the Institute of Medical Research and Medicinal Plants Studies (IMPM) institutional review board (N/Ref.: 087/82-62/MINRESI/M000) and the Inspectorate of Basic Education of the Yaoundé 4 district, Centre region of Cameroon respectively.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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